

**WAC 51-11-0402 Systems analysis**

**402.1 Special Requirements for All Group R Occupancies**

402.1.1 Energy Budgets: Proposed buildings designed in accordance with this section shall be designed to use no more energy from non-renewable sources for space heating and domestic hot water heating than a standard building whose enclosure elements and energy consuming systems are designed in accordance with Section 502.2 of this Code for the appropriate climate zone and heating system type. Energy derived from renewable sources may be excluded from the total annual energy consumption attributed to the alternative building.

402.1.2 Calculation of Energy Consumption: The application for a building permit shall include documentation which demonstrates, using a calculation procedure as listed in Chapter 8, or an approved alternate, that the proposed building's annual space heating energy use does not exceed the annual space heating and water heating energy use of a standard building conforming to Chapter 5 of this Code for the appropriate climate zone. The total calculated annual energy consumption shall be shown in units of kWh/ft<sup>2</sup>-year or Btu/ft<sup>2</sup>-year of conditioned area.

402.1.3 Input Values: The following standardized input values shall be used in calculating annual space heating budgets:

PARAMETER	VALUE
Thermostat set point, heating	65°F
Thermostat set point, cooling	78°F
Thermostat night set back	65°F
Thermostat night set back period	0 hours
Internal Gain	
R-3 and R-4 units	3000 Btu/h
R-1 and R-2 units	1500 Btu/h
Domestic Hot Water Heater Setpoint	120° F
Domestic Hot Water Consumption	20 gallons/person/day

Parameter	Value
Minimum Heat Storage	Calculated using standard engineering practice for the actual building or as approved.
Site Weather Data	Typical meteorological year (TMY) or ersatz TMY data for the closest appropriate TMY site or other sites as approved.
Heating Equipment Efficiency	<u>Equipment shall comply with Section 1411</u>
( <del>Electric resistance heat</del>	<del>1.00</del>
<del>Heat Pumps</del>	<del>6.80 HSPF</del>
<del>Other Fuels</del>	<del>0.78 AFUE))</del>

The standard building shall be modeled with glazing area distributed equally among the four cardinal directions. Parameter values that may be varied by the building designer to model energy saving options include, but are not limited to, the following:

1. Overall thermal transmittance,  $U_o$ , of building envelope or individual building components.
2. Heat storage capacity of building.
3. Glazing orientation; area; and solar heat gain coefficients.
4. Heating system efficiency.

402.1.4 Solar Shading and Access: Building designs using passive solar features with 8% or more south facing equivalent glazing to qualify shall provide to the building official a sun chart or other approved documentation depicting actual site shading for use in calculating compliance under this section. The building shall contain at least 45 Btu/°F for each square foot of south facing glass.

402.1.5 Infiltration: Infiltration levels used shall be set at 0.35 air changes per hour for thermal calculation purposes only.

402.1.6 Heat Pumps: The heating season performance factor (HSPF) for heat pumps shall be calculated using procedures consistent with Section 5.2 of the U.S. Department of Energy "Test Procedure for Central Air Conditioners, Including Heat Pumps," published in the December 27, 1979, Federal Register, Vol. 44, No. 24, 10 CFR 430. Climate data as specified above, the proposed buildings overall thermal performance value

(Btu/°F) and the standardized input assumptions specified above shall be used to model the heat pump's HSPF.

402.2 Energy Analysis: Compliance with this chapter will require an analysis of the annual energy usage, hereinafter called an annual energy analysis.

EXCEPTION: Chapters 5 and 6 of this Code establish criteria for different energy-consuming and enclosure elements of the building which will eliminate the requirement for an annual systems energy analysis while meeting the intent of this Code.

A building designed in accordance with this chapter will be deemed as complying with this Code if the calculated annual energy consumption is not greater than a similar building (defined as a "standard design") whose enclosure elements and energy-consuming systems are designed in accordance with Chapter 5.

For an alternate building design to be considered similar to a "standard design," it shall utilize the same energy source(s) for the same functions and have equal floor area and the same ratio of envelope area to floor area, environmental requirements, occupancy, climate data and usage operational schedule.

402.3 Design: The standard design, conforming to the criteria of Chapter 5 and the proposed alternative design shall be designed on a common basis as specified herein.

The comparison shall be expressed as kBtu or kWh input per square foot of conditioned floor area per year at the building site.

402.4 Analysis Procedure: The analysis of the annual energy usage of the standard and the proposed alternative building and system design shall meet the following criteria:

a. The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be detailed to permit the evaluation of effect of factors specified in Section 402.5.

b. The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be detailed to permit the evaluation of the effect of system design, climatic factors, operational characteristics and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of systems and equipment. The calculation procedure shall be based upon 8,760 hours of operation of the building and its service systems.

402.5 Calculation Procedure: The calculation procedure shall cover the following items:

a. Design requirements--Environmental requirements as required in Chapter 3.

b. Climatic data--Coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.

c. Building data--Orientation, size, shape, mass, air, moisture and heat transfer characteristics.

d. Operational characteristics--Temperature, humidity, ventilation, illumination, control mode for occupied and unoccupied hours.

e. Mechanical equipment--Design capacity, part load profile.

f. Building loads--Internal heat generation, lighting, equipment, number of people during occupied and unoccupied periods.

EXCEPTION: Group R Occupancy shall comply with the calculation procedures in Chapter 8, or an approved alternate.

402.6 Documentation: Proposed alternative designs, submitted as requests for exception to the standard design criteria, shall be accompanied by an energy analysis comparison report. The report shall provide technical detail on the two building and system designs and on the data used in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of Chapter 4 of this Code.

AMENDATORY SECTION (Amending WSR 05-01-013, filed 12/2/04, effective 7/1/05)

**WAC 51-11-1454 Pool covers.** Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90 degrees F shall have a pool cover with a minimum insulation value of R-12.

**Table 14-1A**  
**Unitary Air Conditioners and Condensing Units, Electrically**  
**Operated, Minimum Efficiency Requirements**

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>a</sup>
Air Conditioners, Air Cooled	< 65,000 Btu/h <sup>d</sup>	Split System		ARI 210/240
		<del>Before January 23, 2006</del>	10.0 SEER	
		<del>On or After January 23, 2006<sup>d</sup></del>	<del>12.0</del> 13.0 SEER	
		Single Package		
		<del>Before January 23, 2006</del>	9.7 SEER	

		<u>On or</u> After January 23, 2006 <sup>d</sup>	<del>12.0</del> <u>13.0</u> SEER	
	• 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.3 EER <sup>c</sup>	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	9.7 EER <sup>c</sup>	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split System and Single Package	9.5 EER <sup>c</sup> 9.7 IPLV <sup>c</sup>	
	≥ 760,000 Btu/h	Split System and Single Package	9.2 EER <sup>c</sup> 9.4 IPLV <sup>c</sup>	
Through-the-Wall, Air Cooled	< 30,000 Btu/h <sup>d</sup>	Split System		ARI 210/240
		<del>Before January 23, 2006</del>	10.0 SEER	
		<u>On or</u> After January 23, 2006 <sup>d</sup>	10.9 SEER	
		Single Package		
		<del>Before January 23, 2006</del>	9.7 SEER	
		<u>On or</u> After January 23, 2006 <sup>d</sup>	10.6 SEER	
<del>Small Duct High Velocity, Air Cooled</del>	<del>&lt; 65,000 Btu/h<sup>d</sup></del>	<del>Split System</del>	<del>10.0 SEER</del>	<del>ARI 210/240</del>
Air Conditioners, Water and Evaporatively Cooled	< 65,000 Btu/h	Split System and Single Package	12.1 EER	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	11.5 EER <sup>c</sup>	
	≥ 135,000 Btu/h and • 240,000 Btu/h	Split System and Single Package	11.0 EER <sup>c</sup>	ARI 340/360
	> 240,000 Btu/h	Split System and Single Package	11.0 EER <sup>c</sup> 10.3 IPLV <sup>c</sup>	
Condensing Units, Air Cooled	≥ 135,000 Btu/h		10.1 EER 11.2 IPLV	ARI 365
Condensing Units, Water or Evaporatively Cooled	≥ 135,000 Btu/h		13.1 EER 13.1 IPLV	

<sup>a</sup> Reserved.

<sup>b</sup> IPLVs are only applicable to equipment with capacity modulation.

<sup>c</sup> Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

<sup>d</sup> Date of manufacture for Ssingle-phase air-cooled air-conditioners < 65,000 Btu/h, are as regulated by NAECA. SEER values are those set by NAECA.

**Table 14-1B**  
**Unitary and Applied Heat Pumps, Electrically Operated, Minimum Efficiency Requirements**

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>a</sup>
Air Cooled, (Cooling Mode)	< 65,000 Btu/h <sup>d</sup>	Split System		ARI 210/240
		Before January 23, 2006	10.0 SEER	
		On or After January 23, 2006 <sup>d</sup>	<del>12.0</del> 13.0 SEER	
		Single Package		

		<del>Before January 23, 2006</del> <u>On or After January 23, 2006<sup>d</sup></u>	9.7 SEER <del>12.0</del> <u>13.0</u> SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.1 EER <sup>c</sup>	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	9.3 EER <sup>c</sup>	ARI 340/360
	≥ 240,000 Btu/h	Split System and Single Package	9.0 EER <sup>c</sup> 9.2 IPLV <sup>c</sup>	
Through-the-Wall (Air Cooled, Cooling Mode)	< 30,000 Btu/h <sup>d</sup>	Split System		ARI 210/240
		<del>Before January 23, 2006</del> <u>On or After January 23, 2006<sup>d</sup></u>	10.0 SEER 10.9 SEER	
		Single Package		
		<del>Before January 23, 2006</del> <u>On or After January 23, 2006<sup>d</sup></u>	9.7 SEER 10.6 SEER	
<del>Small Duct High-Velocity (Air Cooled, Cooling Mode)</del>	<del>&lt; 65,000 Btu/h<sup>d</sup></del>	<del>Split System</del>	<del>10.0 SEER</del>	<del>ARI 210/240</del>
Water-Source (Cooling Mode)	< 17,000 Btu/h	86° F Entering Water	11.2 EER	ARI/ISO-13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	86° F Entering Water	12.0 EER	ARI/ISO-13256-1
	≥ 65,000 Btu/h and < 135,000 Btu/h	86° F Entering Water	12.0 EER	ARI/ISO-13256-1
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	59° F Entering Water	16.2 EER	ARI/ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	77° F Entering Water	13.4 EER	ARI/ISO-13256-1
Air Cooled (Heating Mode)	< 65,000 Btu/h <sup>d</sup> (Cooling Capacity)	Split System		ARI 210/240
		<del>Before January 23, 2006</del> <u>On or After January 23, 2006</u>	6.8 HSPF <del>7.4</del> <u>7.7</u> HSPF	
		Single Package		
		<del>Before January 23, 2006</del> <u>On or After January 23, 2006<sup>d</sup></u>	6.6 HSPF <del>7.4</del> <u>7.7</u> HSPF	
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47° F db/43° F wb Outdoor Air	3.2 COP	
		17° F db/15° F wb Outdoor Air	2.2 COP	
	≥ 135,000 Btu/h (Cooling Capacity)	47° F db/43° F wb Outdoor Air	3.1 COP	ARI 340/360
		17° F db/15° F wb Outdoor Air	2.0 COP	

Through-the-Wall (Air Cooled, Heating Mode)	< 30,000 Btu/h <sup>d</sup>	Split System		ARI 210/240
		<del>Before January 23, 2006</del>	6.8 HSPF	
		<u>On or After January 23, 2006<sup>d</sup></u>	7.1 HSPF	
		Single Package		
		<del>Before January 23, 2006</del>	6.6 HSPF	
		<u>On or After January 23, 2006<sup>d</sup></u>	7.0 HSPF	
<del>Small Duct High Velocity (Air Cooled, Heating Mode)</del>	<del>&lt; 65,000 Btu/h<sup>d</sup></del>	<del>Split System</del>	<del>6.8 HSPF</del>	<del>ARI 210/240</del>
Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	68 °F Entering Water	4.2 COP	ARI/ISO-13256-1
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	50 °F Entering Water	3.6 COP	ARI/ISO-13256-1
Ground Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	32 °F Entering Water	3.1 COP	ARI/ISO-13256-1
<sup>a</sup> Reserved. <sup>b</sup> IPLVs and part load rating conditions are only applicable to equipment with capacity modulation. <sup>c</sup> Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat. <sup>d</sup> <u>Date of manufacture for S</u> ingle-phase air-cooled heat pumps < 65,000 Btu/h, <del>are as</del> regulated by NAECA. SEER and HSPF values are those set by NAECA.				

**Table 14-1C**  
**Water Chilling Packages, Minimum Efficiency Requirements**

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>a</sup>
Air Cooled, With Condenser, Electrically Operated	All Capacities		2.80 COP 3.05 IPLV	ARI 550/590
Air Cooled, Without Condenser, Electrically Operated	All Capacities		3.10 COP 3.45 IPLV	
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All Capacities		4.20 COP 5.05 IPLV	ARI 550/590
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	< 150 Tons		4.45 COP 5.20 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons		4.90 COP 5.60 IPLV	
	≥ 300 Tons		5.50 COP 6.15 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons		5.00 COP 5.25 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons		5.55 COP 5.90 IPLV	
	≥ 300 Tons		6.10 COP 6.40 IPLV	

Air Cooled Absorption Single Effect	All Capacities		0.60 COP	ARI 560
Water Cooled Absorption Single Effect	All Capacities		0.70 COP	
Absorption Double Effect, Indirect-Fired	All Capacities		1.00 COP 1.05 IPLV	
Absorption Double Effect, Direct-Fired	All Capacities		1.00 COP 1.00 IPLV	
<sup>a</sup> Reserved.				
<sup>b</sup> The chiller equipment requirements do not apply for chillers used in low temperature applications where the design leaving fluid temperature is less than or equal to 40 °F.				

**Table 14-1D**  
**Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps, Electrically Operated, Minimum Efficiency Requirements**

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>a</sup>
PTAC (Cooling Mode) New Construction	All Capacities	95 °F db Outdoor Air	12.5 - (0.213 x Cap/1000) <sup>b</sup> EER	ARI 310/380
PTAC (Cooling Mode) Replacements <sup>c</sup>	All Capacities	95 °F db Outdoor Air	10.9 - (0.213 x Cap/1000) <sup>b</sup> EER	
PTHP (Cooling Mode) New Construction	All Capacities	95 °F db Outdoor Air	12.3 - (0.213 x Cap/1000) <sup>b</sup> EER	
PTHP (Cooling Mode) Replacements <sup>c</sup>	All Capacities	95 °F db Outdoor Air	10.8 - (0.213 x Cap/1000) <sup>b</sup> EER	
PTHP (Heating Mode) New Construction	All Capacities		3.2 - (0.026 x Cap/1000) <sup>b</sup> COP	
PTHP (Heating Mode) Replacements <sup>c</sup>	All Capacities		2.9 - (0.026 x Cap/1000) <sup>b</sup> COP	
SPVAC (Cooling Mode)	All Capacities	95 °F db/75 °F wb Outdoor Air	8.6 EER	ARI-390
SPVHP (Cooling Mode)	All Capacities	95 °F db/75 °F wb Outdoor Air	8.6 EER	
SPVAC (Heating Mode)	All Capacities	47 °F db/43 °F wb Outdoor Air	2.7 COP	
Room Air Conditioners, with Louvered Sides	< 6,000 Btu/h		9.7 EER	ANSI/AH AM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h		9.7 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h		9.8 EER	
	≥ 14,000 Btu/h and < 20,000 Btu/h		9.7 EER	
	≥ 20,000 Btu/h		8.5 EER	
Room Air Conditioners, without Louvered Sides	< 8,000 Btu/h		9.0 EER	
	≥ 8,000 Btu/h and < 20,000 Btu/h		8.5 EER	



	$\geq 20,000$ Btu/h		8.5 EER	
Room Air Conditioner Heat Pumps with Louvered Sides	$< 20,000$ Btu/h		9.0 EER	
	$\geq 20,000$ Btu/h		8.5 EER	
Room Air Conditioner Heat Pumps without Louvered Sides	$< 14,000$ Btu/h		8.5 EER	
	$\geq 14,000$ Btu/h		8.0 EER	
Room Air Conditioner, Casement Only	All Capacities		8.7 EER	
Room Air Conditioner, Casement – Slider	All Capacities		9.5 EER	

<sup>a</sup> Reserved.

<sup>b</sup> Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

<sup>c</sup> Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

<sup>d</sup> Casement room air conditioners are not separate product classes under current minimum efficiency column.

<sup>e</sup> New room air conditioner standards, covered by NAECA became effective October 1, 2000.

**Table 14-1E**  
**Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters, Minimum Efficiency Requirements**

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>a</sup>
Warm Air Furnace, Gas-Fired	$< 225,000$ Btu/h (66 kW)		78% AFUE or 80% E <sub>t</sub> <sup>c</sup>	DOE 10 CFR Part 430 or ANSI Z21.47
	$\geq 225,000$ Btu/h (66 kW)	Maximum Capacity <sup>c</sup> Minimum Capacity <sup>c</sup>	80% E <sub>c</sub> <sup>f</sup>	ANSI Z21.47
Warm Air Furnace, Oil-Fired	$< 225,000$ Btu/h (66 kW)		78% AFUE or 80% E <sub>t</sub> <sup>c</sup>	DOE 10 CFR Part 430 or UL 727
	$\geq 225,000$ Btu/h (66 kW)	Maximum Capacity <sup>b</sup> Minimum Capacity <sup>b</sup>	81% E <sub>t</sub> <sup>g</sup> —	UL 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity <sup>b</sup> Minimum Capacity <sup>b</sup>	80% E <sub>c</sub> <sup>e</sup> —	ANSI Z83.9
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity <sup>b</sup> Minimum Capacity <sup>b</sup>	80% E <sub>c</sub> <sup>e</sup> —	ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity <sup>b</sup> Minimum Capacity <sup>b</sup>	80% E <sub>c</sub> <sup>e</sup> —	UL 731

<sup>a</sup> Reserved.

<sup>b</sup> Minimum and maximum ratings as provided for and allowed by the unit's controls.

<sup>c</sup> Combination units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]) may comply with either rating.

<sup>d</sup>  $E_t$  = Thermal efficiency. See test procedure for detailed discussion.

<sup>e</sup>  $E_c$  = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

<sup>f</sup>  $E_c$  = Combustion efficiency. Units must also include an IID, have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

<sup>g</sup>  $E_t$  = Thermal efficiency. Units must also include an IID, have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

**Table 14-1F**  
**Boilers, Gas- and Oil-Fired, Minimum Efficiency Requirements**

Equipment Type <sup>f</sup>	Size Category	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure
Boilers, Gas-Fired	< 300,000 Btu/h	Hot Water	80% AFUE	DOE 10 CFR Part 430
		Steam	75% AFUE	
	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h	Maximum Capacity <sup>b</sup>	75% $E_t$	H.I. Htg Boiler Std
	> 2,500,000 Btu/h <sup>f</sup>	Hot Water	80% $E_c$	
	> 2,500,000 Btu/h <sup>f</sup>	Steam	80% $E_c$	
Boilers, Oil-Fired	< 300,000 Btu/h		80% AFUE	DOE 10 CFR Part 430
	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h	Maximum Capacity <sup>b</sup>	78% $E_t$	H.I. Htg Boiler Std
	> 2,500,000 Btu/h <sup>f</sup>	Hot Water	83% $E_c$	
	> 2,500,000 Btu/h <sup>f</sup>	Steam	83% $E_c$	
Oil-Fired (Residual)	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h	Maximum Capacity <sup>b</sup>	78% $E_t$	H.I. Htg Boiler Std
	> 2,500,000 Btu/h <sup>f</sup>	Hot Water	83% $E_c$	
	> 2,500,000 Btu/h <sup>f</sup>	Steam	83% $E_c$	

<sup>a</sup> Reserved.

<sup>b</sup> Minimum and maximum ratings as provided for and allowed by the unit's controls.

<sup>c</sup>  $E_c$  = Combustion efficiency (100% less flue losses). See reference document for detailed information.

<sup>d</sup>  $E_t$  = Thermal efficiency. See reference document for detailed information.

<sup>e</sup> Alternate test procedures used at the manufacturer's option are ASME PTC-4.1 for units over 5,000,000 Btu/h input, or ANSI Z21.13 for units greater than or equal to 300,000 Btu/h and less than or equal to 2,500,000 Btu/h input.

<sup>f</sup> These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

**Table 14-1G**

### Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Sub-Category or Rating Condition	Minimum Efficiency <sup>b</sup>	Test Procedure <sup>c</sup>
Propeller or Axial Fan Cooling Towers	All	95°F (35°C) Entering Water 85°F (29°C) Leaving Water 75°F (24°C) wb Outdoor Air	≥38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Cooling Towers	All	95°F (35°C) Entering Water 85°F (29°C) Leaving Water 75°F (24°C) wb Outdoor Air	≥ 20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Air Cooled Condensers	All	125°F (52°C) Condensing Temperature R22 Test Fluid 190°F (88°C) Entering Gas Temperature 15°F (8°C) Subcooling 95°F (35°C) Entering Drybulb	≥176,000 Btu/h · hp	ARI 460
<sup>a</sup> For purposes of this table, cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power. <sup>b</sup> For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power. <sup>c</sup> Reserved.				

TABLE 14-2 RESERVED

TABLE 14-3 RESERVED

TABLE 14-4  
Energy Efficient Electric Motors  
Minimum Nominal Full-Load Efficiency

	Open Motors			Closed Motors		
Synchronous Speed (RPM)	3,600	1,800	1,200	3,600	1,800	1,200
HP	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
1.0	-	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2.0	84.0	84.0	85.5	84.0	84.0	86.5
3.0	84.0	86.5	86.5	85.5	87.5	87.5
5.0	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10.0	88.5	89.5	90.2	89.5	89.5	89.5

15.0	89.5	91.0	90.2	90.2	91.0	90.2
20.0	90.2	91.0	91.0	90.2	91.0	90.2
25.0	91.0	91.7	91.7	91.0	92.4	91.7
30.0	91.0	92.4	92.4	91.0	92.4	91.7
40.0	91.7	93.0	93.0	91.7	93.0	93.0
50.0	92.4	93.0	93.0	92.4	93.0	93.0
60.0	93.0	93.6	93.6	93.0	93.6	93.6
75.0	93.0	94.1	93.6	93.0	94.1	93.6
100.0	93.0	94.1	94.1	93.6	94.5	94.1
125.0	93.6	94.5	94.1	94.5	94.5	94.1
150.0	93.6	95.0	94.5	94.5	95.0	95.0
200.0	94.5	95.0	94.5	95.0	95.0	95.0

**TABLE 14-5**  
**Duct Insulation**

Duct Type	Duct Location	Insulation R-Value	Other Requirements
Supply, Return	Not within conditioned space: On exterior of building, on roof, in attic, in enclosed ceiling space, in walls, in garage, in crawl spaces	R-7	Approved weather proof barrier
Outside air intake	Within conditioned space	R-7	See Section 1414.2
Supply, Return, Outside air intake	Not within conditioned space: in concrete, in ground	R-5.3	
Supply with supply air temperature < 55 °F or > 105°F	Within conditioned space	R-3.3	

Note: Requirements apply to the duct type listed, whether heated or mechanically cooled. Mechanically cooled ducts requiring insulation shall have a vapor retarder, with a perm rating not greater than 0.5 and all joints sealed.

**TABLE 14-6**  
**Minimum Pipe Insulation (inches)<sup>1</sup>**

Fluid Design Operating Temp. Range, °F	Insulation Conductivity		Nominal Pipe Diameter (in.)					
	Conductivity Range Btu • in. / (h • ft <sup>2</sup> • °F)	Mean Rating Temp. °F	Runouts <sup>2</sup> up to 2	1 and less	> 1 to 2	> 2 to 4	> 4 to 6	> 6
Heating systems (Steam, Steam Condensate, and Hot water)			Nominal Insulation Thickness					

Above 350	0.32-0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251-350	0.29-0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201-250	0.27-0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141-200	0.25-0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.24-0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems								
105 and Greater	0.24-0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine[,] and Refrigerant)								
40-55	0.23-0.27	75	0.5	0.5	0.75	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

- Alternative Insulation Types. Insulation thicknesses in Table 14-6 are based on insulation with thermal conductivities within the range listed in Table 14-6 for each fluid operating temperature range, rated in accordance with ASTM C 335-84 at the mean temperature listed in the table. For insulation that has a conductivity outside the range shown in Table 14-6 for the applicable fluid operating temperature range at the mean rating temperature shown (when rounded to the nearest 0.01 Btu · in. / (h · ft<sup>2</sup> · °F)), the minimum thickness shall be determined in accordance with the following equation:

$$T = PR[(1 + t/PR)^{K/k} - 1]$$

Where

- T = Minimum insulation thickness for material with conductivity K, inches.  
PR = Pipe actual outside radius, inches.  
t = Insulation thickness from Table 14-6, inches  
K = conductivity of alternate material at the mean rating temperature indicated in Table 14-6 for the applicable fluid temperature range, Btu · in. / (h · ft<sup>2</sup> · °F)  
k = the lower value of the conductivity range listed in Table 14-6 for the applicable fluid temperature range, Btu · in. / (h · ft<sup>2</sup> · °F)

- Runouts to individual terminal units not exceeding 12 ft. in length.